FREE-AIR SUMMARY

By V. E. JAKL

The average free-air temperatures at aerological stations for which normals are available (see Table 1) show departures corresponding to those at the surface, as shown on Chart III, this REVIEW. At Royal Center the departure was greatest, and negative; Ellendale, where the temperature was moderately above normal, was the only station showing a positive departure. At all stations the departure diminished somewhat with altitude. Relative humidity was about normal, except over Ellendale, where it was decidedly below normal.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during April, 1926*

TEMPERATURE (°C.)

Altitude, m. s. l.	Broken Arrow, Okla. (233 meters)		Due West S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)		*Washington, D. C. (7 meters)
	Mean	Departure from 8-year mean	Mean	Departure from 6-year mean	Mean	Departure from 9-year mean	Mean	Departure from 8-year mean	Mean	Departure from 8-year mean	mean
Meters											
Surface	12.5	−2.9	15.9	−1.3	7.4	+1.4	14.8	−3.3	5.7	−4.9	8.9
250	12.4	−2.9	15.6	−1.3			14.1	−3.3	5.4	−5.0	7.6
500	10.8	−2.9	13.5	−1.2	7.0	+1.3	12.7	−3.1	3.2	−4.9	6.3
750	9.6	−2.7	12.1	−0.9	5.6	+1.3	12.3	−2.5	2.1	−4.7	5.1
1,000	8.7	−2.6	11.0	−0.7	4.2	+1.0	12.1	−1.9	1.6	−4.0	4.1
1,250	8.0	−2.2	9.5	−0.9	2.7	+0.7	11.5	−1.7	0.7	−3.7	3.2
1,500	7.4	−1.7	8.0	−1.0	1.5	+0.7	10.8	−1.7	−0.2	−3.5	1.8
2,000	6.0	−0.7	5.1	−0.9	−1.6	+0.2	8.5	−1.9	−1.7	−2.7	−0.3
2,500	3.5	−0.3	2.0	−1.4	−3.9	+0.7	6.0	−1.7	−4.1	−2.5	−2.1
3,000	0.8	+0.1	−0.8	−1.6	−6.7	+0.8	3.2	−1.7	−6.6	−2.4	−4.3
3,500	−2.0	+0.4	−3.3	−1.5	−9.9	+0.6	0.0	−2.1	−8.8	−2.1	−6.9
4,000	−4.9	+0.5	−6.3	−2.0	−13.0	+0.7			−11.0	−2.1	−9.6
4,500	−7.8	+0.5			−15.6	+1.0			−13.2	−1.7	−13.0
5,000	−10.1	+1.0									

RELATIVE HUMIDITY (%)

Surface	63	−1	57	−3	47	−18	77	+5	61	+2	70
250	63	−1	57	−3			76	+4	61	+2	69
500	63	0	57	−4	47	−17	74	+4	61	+1	66
750	62	0	57	−4	46	−16	70	+3	62	+1	64
1,000	62	+2	57	−4	46	−15	63	+1	63	+2	63
1,250	58	0	55	−6	48	−12	57	0	63	+3	64
1,500	56	0	52	−8	48	−11	51	0	61	+2	66
2,000	51	−1	49	−10	50	−7	50	+4	56	−1	66
2,500	48	−3	52	−3	47	−11	51	+6	53	−2	65
3,000	49	−2	53	+2	49	−9	52	+8	48	−5	63
3,500	46	−6	53	+6	53	−6	38	−8	48	−5	65
4,000	46	−4	49	+3	56	−4			49	−2	62
4,500	47	−4			47	−11			45	−3	58
5,000	47	−6									

VAPOR PRESSURE (*mb.*)

Surface	9.10	−2.48	10.16	−1.82	4.45	−1.48	13.15	−2.06	6.14	−2.42	8.50
250	9.03	−2.45	10.08	−1.71			12.46	−2.04	6.07	−2.35	7.68
500	8.02	−2.16	8.84	−1.64	4.35	−1.42	11.08	−1.73	5.18	−2.07	6.74
750	7.24	−1.86	8.04	−1.48	3.89	−1.22	10.13	−1.32	4.66	−1.85	6.06
1,000	6.94	−1.29	7.58	−1.17	3.59	−1.05	8.95	−1.06	4.45	−1.45	5.56
1,250	6.31	−1.08	6.73	−1.19	3.36	−0.87	7.61	−1.01	4.24	−1.10	5.32
1,500	5.90	−0.77	5.73	−1.36	3.15	−0.66	6.41	−0.84	3.79	−1.07	4.99
2,000	4.76	−0.47	4.34	−1.19	2.76	−0.26	5.53	−0.03	3.02	−1.01	4.28
2,500	3.71	−0.45	3.67	−0.45	2.36	−0.08	4.83	+0.31	2.20	−0.97	3.61
3,000	3.12	−0.27	2.93	−0.08	1.97	+0.02	4.18	+0.48	1.70	−0.82	2.87
3,500	2.50	−0.30	2.51	+0.16	1.62	+0.03	2.40	−0.76	1.37	−0.77	2.37
4,000	2.14	−0.06	1.92	+0.07	1.19	−0.05			1.16	−0.67	1.77
4,500	1.82	−0.07			0.63	−0.26			0.93	−0.58	1.34
5,000	1.58	−0.07									

* Naval air station.

The departure of resultant winds from normal was not of much importance at most stations. (See Table 2.) There was, however, a tendency for a little more northerly component or less southerly component at those stations where the temperature was below normal. This was especially evident over Royal Center, where in the lower levels the resultant winds were northwesterly (normal, southwesterly), while with increasing altitude the resultant direction (corresponding with the decrease in negative temperature departure) became more nearly the normal westerly direction.

Well-defined periods of east component free-air winds prevailing over extended areas were absent, except on the 10th–13th up to 4,000 to 7,000 meters at Denver, Drexel, and Royal Center, and on the 15th above about 5,000 meters at Broken Arrow, Denver, and Drexel. In the former period the wind directions in the high altitudes conformed to the sea-level pressure situation at the stations concerned, i. e., the gradient was north-south; on the 15th however, the easterly winds aloft can be accounted for only by a reversal of pressure gradient with height. The records at Ellendale and Groesbeck indeed show a tendency to higher free-air temperatures over the former station than over the latter. The highest wind velocity recorded was 46 m. p. s. (over 100 m. p. h.) from the west at 7,700 meters over Ellendale on the 8th. The surface map showed a weak pressure gradient over Ellendale within an extensive moderate HIGH.

An example of rapid increase in velocity with altitude, followed by an almost as rapid decrease, is shown by the records of both kite and two-theodolite pilot-balloon observations at Ellendale on the morning of the 19th. The pilot-balloon observation shows an increase from 5 m. p. s. at the ground to 23 m. p. s. at 400 meters, thence a decrease to 6 m. p. s. at 1,600 meters. This was associated, as usual, with an inversion in temperature at the altitude of highest wind velocity, in the southwesterly wind in the rear of a HIGH. In distinction to this, the afternoon pilot balloon observation at Royal Center on the 24th showed a strong lapse rate in temperature and strong wind in the lower levels where only friction and turbulence determine the increase in wind velocity with altitude, the increase in velocity being from 20 meters per second southwest on the ground to 36 meters per second west-southwest at 1,000 meters. An intense LOW was centered not far to the north. In the case at Ellendale on the 19th the rate of increase in velocity with altitude was more than six times that at Royal Center on the 24th.

The kite observation at Ellendale on the 29th is a good example of a lapse rate approximating the dry adiabatic, with a regular increase in relative humidity extending to 4,340 meters, where A–Cu. clouds prevailed. The effect of convection up to that height is shown by the two theodolite pilot balloon observation, taken almost simultaneously, in front of a LOW moving rapidly from the northwest but which caused no precipitation at Ellendale. This case simply emphasizes what has been previously referred to in the free-air summaries, viz, that over interior regions a high lapse rate of itself does not necessarily favor precipitation. The free-air data for this observation are given in the following table:

Altitude m. s. l.	Temperature	Δ t 100 m	Relative humidity	Wind	
				Direction	Velocity
Meters	° *C.*		*Per cent*		*M. p. s.*
Surface 444	29.8		17	WNW	7.6
864	23.6	1.48	18	W	8.6
1,759	14.4	.92	25	W	11.1
2,885	2.9	1.02	44	W	10.8
4,340	−10.0	.89	100	WNW	15.2
4,827	−12.3	.47	84	WNW	16.0

NOTE: Beginning with this number of the REVIEW the data for Washington, D. C., will be printed in Tables 1 and 2, in the space made available by the discontinuance of the Drexel station. The Washington data in Table 1 are taken from the Naval Air Station airplane observations, and in Table 2 from the pilot-balloon observations at the Weather Bureau.

TABLE 2.—*Free-air resultant winds (m. p. s.) during April, 1926*

Altitude, m. s. l.	Broken Arrow, Okla. (233 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)				Washington, D. C. (34 meters)	
	Mean		8-year mean		Mean		6-year mean		Mean		9-year mean		Mean		8-year mean		Mean		8-year mean		Mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Meters																						
Surface	N. 55°W.	0.9	S. 5°W.	2.4	S. 72°W.	2.9	S. 79°W.	1.6	N. 76°W.	2.1	N. 18°W.	1.6	N. 62°W.	0.4	S. 3°E.	2.2	N. 66°W.	2.5	S. 54°W.	1.9	N. 25°W.	1.6
250	N. 61°W.	0.9	S. 5°W.	2.5	S. 73°W.	3.1	S. 77°W.	1.8	----	----	----	----	S. 62°W.	0.3	S. 4°E.	2.9	N. 70°W.	2.7	S. 53°W.	2.0	N. 70°W.	2.9
500	S. 59°W.	1.3	S. 11°W.	3.9	S. 74°W.	4.7	S. 75°W.	2.7	N. 52°W.	3.6	N. 18°W.	1.6	S. 10°E.	1.4	S. 3°E.	4.4	N. 66°W.	5.0	S. 53°W.	3.8	N. 81°W.	4.7
750	S. 71°W.	1.9	S. 16°W.	4.7	S. 73°W.	5.3	S. 69°W.	3.4	N. 48°W.	4.2	N. 31°W.	1.2	S. 13°W.	2.2	S. 12°W.	5.0	N. 60°W.	6.2	S. 59°W.	4.8	N. 76°W.	6.8
1,000	S. 82°W.	3.0	S. 28°W.	5.2	S. 73°W.	6.3	S. 65°W.	4.1	N. 52°W.	4.4	N. 54°W.	1.4	S. 12°W.	2.4	S. 21°W.	5.2	N. 56°W.	7.3	S. 64°W.	5.5	N. 82°W.	9.9
1,250	S. 80°W.	3.3	S. 40°W.	5.4	S. 73°W.	8.6	S. 69°W.	5.7	N. 54°W.	4.8	N. 60°W.	2.2	S. 21°W.	2.8	S. 31°W.	6.1	N. 59°W.	8.9	S. 75°W.	6.5	----	----
1,500	S. 83°W.	3.7	S 52°W.	6.0	S. 77°W.	10.1	S. 71°W.	6.9	N. 57°W.	5.4	N. 63°W.	2.7	S 39°W.	3.3	S. 37°W.	6.7	N. 63°W.	10.1	S. 83°W.	7.3	N. 78°W.	10.0
2,000	N. 72°W.	5.5	S. 65°W.	7.1	S. 76°W.	10.9	S. 80°W.	8.3	N. 55°W.	7.3	N. 73°W.	3.5	S. 67°W.	5.2	S. 40°W.	7.7	N. 65°W.	12.0	S. 89°W.	8.5	N. 78°W.	11.6
2,500	N. 78°W.	6.0	S. 72°W.	7.9	S. 74°W.	11.1	S. 80°W.	10.0	N. 56°W.	9.8	N. 79°W.	5.1	S. 64°W.	5.8	S. 59°W.	8.3	N. 74°W.	14.0	N. 85°W.	9.0	N. 81°W.	14.2
3,000	N. 72°W.	5.3	S. 82°W.	7.8	S. 74°W.	13.7	S. 81°W.	10.7	N. 58°W.	11.6	N. 77°W.	6.8	N. 84°W.	4.3	S. 65°W.	10.1	N. 68°W.	11.6	N. 83°W.	10.0	S. 89°W.	15.2
3,500	N. 64°W.	6.3	S. 87°W.	10.0	S. 81°W.	10.5	N. 86°W.	11.5	N. 54°W.	12.2	N. 78°W.	8.2	S. 60°W.	5.2	S. 70°W.	10.1	N. 71°W.	15.8	S. 89°W.	11.8	N. 85°W.	12.8
4,000	N. 81°W.	6.3	S. 84°W.	11.4	S. 64°W.	9.2	N. 82°W.	12.5	N. 49°W.	13.8	N. 71°W.	9.6	----	----	----	----	N. 62°W.	20.2	N. 84°W.	14.6	N. 69°W.	13.2
4,500	N. 78°W.	8.3	S. 86°W.	12.2	S. 75°W.	12.2	N. 63°W.	13.2	N. 50°W.	12.8	N. 60°W.	9.6	----	----	----	----	N. 62°W.	22.3	N. 76°W.	14.7	N. 76°W.	13.7
5,000	N. 65°W.	6.2	N. 81°W.	10.6	----	----	----	----	N. 68°W.	16.0	N. 73°W.	15.3	----	----	----	----	----	----	----	----	----	----

THE WEATHER ELEMENTS

By P. C. DAY, in Charge of Division

PRESSURE AND WINDS

While the weather did not vary greatly at any particular time from that usually expected at intervals in April, still the long continuance of certain types of weather resulted in the establishment of unusual conditions for the month as a whole, particularly as to temperature and precipitation.

Variations in pressure were mainly moderate and there were few extensive or severe storm areas.

The most important cyclonic conditions were those which gave beneficial precipitation over the Pacific coast early in the month, mainly heavy rains about the 5th to 9th throughout California, particularly in the south, where most needed, greatly relieving a severe drought that had persisted since near the middle of February, and affording a long-delayed opportunity for replenishing alarmingly low-water supplies. Precipitation during this period was in many instances the greatest ever recorded in April, and removed all danger to crops from a water shortage. The rain area extended into other portions of the Southwest, giving frequent precipitation in Arizona and portions of surrounding States, where locally the monthly falls were equal to or even greater than occasionally occur in an entire year.

Over most other southern districts precipitation was rather frequent during the first half of the month, due to the passage over those districts of cyclonic areas usually of only moderate strength. During the latter half there was little precipitation over those districts, and over most central and northern sections of the country storm activity throughout the month was unimportant.

The principal cyclones aside from those mentioned were those of the 1st to 3d and 24th to 25th. During the 1st to 3d a low-pressure area moved from the southern Plains northeastward to the Lower Lakes, attended by some unusually heavy snows over the northern side of the storm track, particularly in a narrow area from the southern Rocky Mountains northeastward through northern Kansas to southern Lake Michigan. Locally the depths ranged up to 10 inches or more and with considerable depths remaining from the heavy falls over practically the same area late in March, conditions approached those associated with a severe winter storm.

The storm of the 24th and 25th moved from the middle Mississippi Valley to the Great Lakes, where on the morning of the 24th the pressure had fallen to only slightly above 29 inches, and precipitation had covered a wide area of the central valleys extending from the Gulf of Mexico to the Canadian border. During the following 24 hours the storm center advanced to western Ontario, but precipitation was confined mainly to the northern districts from the Great Lakes and Ohio Valley eastward. During the last few days several unimportant cyclones moved over the Great Lakes and thence northeastward, but the accompanying precipitation was light and confined to rather small areas.

Mild anticyclonic conditions persisted over the interior during much of the month, particularly over the Missouri Valley, though during the latter part high pressure was rather persistent over the Gulf States.

The average pressure was highest from the upper Missouri Valley southeastward to the Florida Peninsula, and lowest over the Canadian Maritime Provinces, being generally considerably above normal in the first-mentioned area and also somewhat above over adjacent areas on the east and west, becoming below normal over the Atlantic coast States from the Carolinas northward and over the eastern Canadian Provinces and along the Pacific coast.

Generally the average pressure for April is distinctly less than that for March in all districts save in the far Northwest and extreme Northeast.

For April, 1926, the average was nearly everywhere less, markedly so from the Missouri Valley westward and over western Canada; also, though to a less degree, over eastern Canada, where it is usually higher.

The prevailing winds were mainly from west to northwest from the Mississippi Valley eastward, southerly over Texas and some near-by areas, and generally northerly in the Missouri Valley and far Northwest.

The severe wind and other storms occurred locally at widely separated dates and places.

The greatest damage by electrical storms occurred near San Luis Obispo, Calif., and near Los Angeles, on the 7th. A full account of the former is printed elsewhere in this number of the REVIEW.